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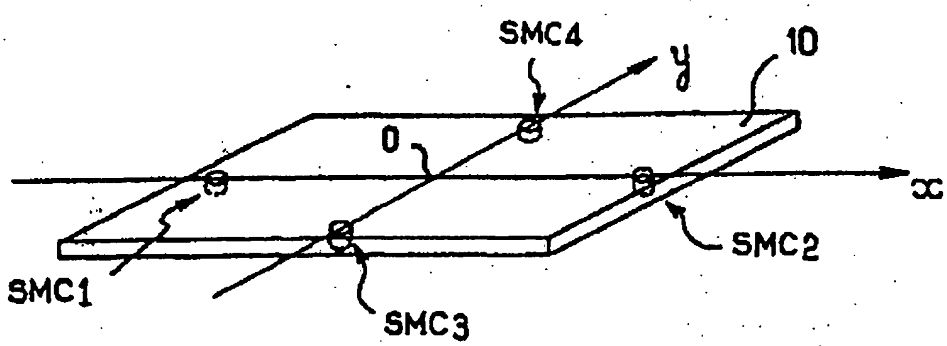

(57) Abstract

The invention relates to a device for acquiring co-ordinates of interaction points of an acoustic source with the surface of a plate of finite dimensions comprising a set of sound sensors (SMC1 to SMC4) each formed with a pair of piezoelectric transducers located opposite each other on either side of the plate, the device comprising processing means for determining the co-ordinates of said interaction point by analyzing the difference in propagation time of the sound waves transmitted by the source to different sensors. The invention is characterized in that procession means comprises associated with each sensor a particular electronic circuit comprising cascade wideband pre-amplifier means, and selective amplifying means centered on a first predetermined frequency.

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INTERACTIVE ACOUSTIC PLATE WITH IMPROVED SIGNAL PROCESSING MEANS

The present invention relates in general to devices for interactive communication between a user and a machine.

More precisely, the invention relates to a device for collecting and processing sound waves transmitted by a user to a plate used as interface with a machine, said device analyzing propagation time of sound waves in the plate especially for measuring impact co-ordinates X, Y on the plate surface.

Patent WO 96/11378 describes a device for acquiring co-ordinates X, Y of a point on rigid plate to which a source punctually emits packs of waves, by analyzing propagation time of the waves in the plate in two X and Y directions of the plate.

In this device, two pairs of transducers are respectively associated to each direction X, Y. Position of the source relative to each direction is determined by the measurement of difference of arrival time of packs of waves respectively on both pairs of transducers of said direction. The device also comprises downstream of transducers means for processing the asymmetric Lamp mode A_0 of sound waves propagating in the plate.

The source may for example be a stiletto fitted with means for emitting waves, or again a simple hard object impacting on the plate and thus generating the packs of waves. The device comprises a machine (for example a calculator) for processing data, that can control the emission of signals to the user destination permitting interactive operation.

The invention purpose is to improve quality and reliability of the sound waves reception in a device of the above-mentioned type.

Another invention purpose is to also improve the device ergonomy by extending the possibility of communication between a user and the interface made up with the plate, especially by allowing a communication without any shock of an object to the plate.

Finally, the invention also aims to improve the device security, especially in the case of a plate made out with a fragile material such as glass.

To attain these purposes, the invention proposes a device for acquiring the co-ordinates of interaction point of an acoustic source with the surface of a plate having finite dimensions comprising a set of sound sensors formed each with a pair of piezoelectric transducers located in opposition on either side of the plate; the device comprising processing means for determining co-ordinates of said interaction point by analyzing the propagation time difference of sound waves emitted by the source to different sensors, device characterized by the fact that processing means comprise in association with each sensor a respective electronic circuit comprising in cascade means for performing wide band pre-amplification, and selective amplification means centered on a first predetermined frequency,

Preferred but non-limiting aspects of the device according to the invention are as follows:

- sensor number is four and piezoelectric transducers of each sensor are piezoelectric ceramic disks bonded on both sides of the plate, such that the four sensors form on the plate the apexes of a diamond whose center is the origin of co-ordinates,

- said first predetermined frequency is in the order of 100 kHz and said centered selective amplification means comprise a selective amplifier for detecting the energy fraction generated by the source in the proximity of said first predetermined frequency.

- localization of an interaction point of the source with the plate consists of extracting the ultrasound frequency component at the proximity of 100 kHz generated by the impact of a hard object such as finger nail, metal key, ball-point pen, hard plastic material and determining on the one hand the difference of propagation time between two sensors of a first pair and on the other hand that of two sensors of a second pair, such that Cartesian co-ordinates of the impact point (x_r, y_r) on the plate are provided by the formula:

:

wherein x_M and y_M designate the sensor position relative to the diamond center, √ the speed of anti-symmetrical Lamb mode in the plate, Δt_x the difference of propagation time of the packs of waves generated by the impact between sensors of the first pair and Δt_y those of the second pair, k_x and k_y coefficients equal to +1 or −1 and sign(x_r), sign(y_r) signs of co-ordinates x_r and y_r.

- said electronic circuits associated to sensors comprise in cascade a wide band pre-amplifier stage, a squaring stage, a detection stage, an integration stage and an adaptation to a logic level stage.

- said logic level is of CMOS type,

- electronic circuits associated to respective sensors comprise upstream said selective amplification means, a derivation toward means for analyzing of at least another spectral component in order to characterize the nature of acoustic source or dimensions of the source,

- analyzing means comprise at least one selective pass-band filter individually centered on a predetermined centering frequency different from the first predetermined frequency, and processing means comprise downstream of said electronic circuits associated to respective sensors a programmable logic module.

- said centering frequency is located in the audible spectrum, preferably in the upper limit of audible spectrum,

- said programmable logic module comprises a logic component fitted for determining whether a signal generated by the source in the plate comprises significant components simultaneously around the first predetermined frequency and around the centering frequency (or frequencies).

- means are provided for determining the signal intensity transmitted by the source to the plate around the first predetermined frequency,

- said means for determining intensity comprise means for measuring in the form of a reverberation the number of echoes on the plate edges of a sound wave generated around the first predetermined frequency by an interaction of the source with the plate,

- a 12-bit counter is provided for measuring the reverberation, powered by the output of selective amplification means centered on a first predetermined frequency issued from the sensors and adapted to the logic CMOS,

- impact counter is activated by a stable clock, the counting being authorized as long as the envelope of successive echoes of the wave train generated in the plate at the proximity of the first predetermined frequency remains above a predetermined frequency,

- means are also provided for determining the signal transmitted by the source to the plate at least around one centering frequency different from the first predetermined frequency,

- at least another counter is provided, individually associated with a centering frequency and fitted for counting the number of echoes on the

plate edges of a sound wave generated around said centering frequency associated with an interaction of the source and the plate,

- means are provided for determining the nature of the source in function of the signal intensity transmitted from the source to the plate around the first predetermined frequency and the centering frequency (or frequencies),

- means are provided for sending to a user luminous message through a peripheral connected to the processing means, indicating to the user whether an interaction has generated a sound signal located in the desired reverberation range,

- according to a threshold value attained by one or several counters associated each individually with a frequency, the device is fitted for triggering preventive actions for the plate security, for example by activating an alarm or triggering the closing of a metal curtain covering the plate,

- the source is capable of exciting the plate without making said plate transmit sound waves to ambient environment,

- the source is a stiletto whose hollow longitudinal main body comprises an electrical energy source, an electrical pulse generator fitted for being powered by the electrical energy source, a piezoelectric ceramic disk fitted for being excited by the pulse generator for bringing in longitudinal resonance a cavity of the main body filled with a component having mechanical impedance comparable to that of the material making up the main body, said cavity of the main body being closed with a pellet made out of soft material with impedance comparable to that of silicone,

- electrical pulse generator is fitted for continuously emitting bursts of pulses around the 100 kHz and the hollow main body is made out with material, which may enter into resonance around this frequency, for example a plastic material,

- component filling said cavity of the main body is a liquid anti-freeze,

- the stiletto comprises a power switch for controlling the emission of sound waves,

- the plate is fitted for being excited by a compression wave generated by the user voice, and the output of wide band pre-amplification stage of at least one of the electronic circuits associated with respective sensors is derived toward pass-bas amplifier, for example order 6 Bessel filters limited to audible band,

- output of pass-bas amplifiers is directed to an output connector of the stereo Jack type and then to an audio acquisition board,

- one or several electronic band-cutting filters are inserted after pass-bas filters to compensate the plate own resonance at certain frequencies,

- it comprises a software filter with inverse transfer function of the acoustic-electrical frequency response of the plate for a given frequency range of few kHz, for processing audio signals issued from the glass plate,

- one of the sensors is fitted of being commuted into a transmitter of a pack of ultrasound wave in order to trigger the plate integrity test comprising the measurement of:

- the difference of propagation time of the pack of waves between different sensors,
- and the reverberation of the pack of waves thanks to an impact counter,

and the device comprises means for comparing said reverberation value to reference values and means for triggering preventive actions for the plate security, for example by activating an alarm or the closing of a metal curtain covering the plate,

- integrity test is triggered by a writing instruction to a memory address, starting a general counter and an oscillator from which a burst of logic and its inverse logic are suited for activating the grids of electronic components controlling the adaptation of the logic burst to a higher voltage applied to the sensor commuted into transmitter, said higher voltage being obtained with an oscillator and a diode pump connected to reservoir capacitors.

- the oscillator is a relaxation oscillator operating at about 100 kHz, said higher voltage is in the order of 60 volts and said electronic components are NMOS and PMOS transistors,

- Input stage of electronic circuit associated to sensor commuted into transmitter is protected from the bust of higher voltage with commutation transistors NMOS blocked during the burst and passing when the sensor fitted for being commuted into transmitter is in receiving mode,

- plate integrity test is conducted at the start of the device and just after an interaction between the source and the plate,

- additional transducer pairs are dedicated to integrity test,

- additional transducer pairs are also in the number of four and define a second diamond directed at 45° relative to the sensor diamond, additional transducer pairs also participating to the measurement of co-ordinates of the interaction point between the source and the plate,

- the device constitutes a peripheral interface with a machine, which receives signals issued from processing means, and which in function of said controlling signals controls the execution of files contained in the computer with various known-type peripherals connected to the computer such as for non-limiting example: video projector, light sources, loud-speakers, printer, or again an automated box controlling mechanical action such as closing the protective curtain,

- said machine is a computer equipped with a screen,

- a pixel of co-ordinates on the computer screen showing an image of the plate is associated with a physical point of the co-ordinate plate, conversion of co-ordinates comprising the following operations:

a) visual marking of the sensor center,

b) recording a digital image including the origin,

c) delimiting on digital image a working frame with center C, and calculation of the length and height in pixels of the working frame,

d) definition of a homothetic correspondence which provides the working frame scale, i.e. the corresponding length L and height l in millimeters on the plate to the drawn working frame,

e) positioning on digital image a cursor pointing the sensor center, i.e. the origin of real co-ordinates of the plate, visually shown in a),

such that any pixel of co-ordinates N_{xq}, N_{yq} of the working frame will be connected to its real co-ordinates according to the formula:

- one portion of the plate defined as working frame equivalent to the computer screen is divisible into zones of any forms, each zone corresponding to a field of the plate digital image which is stored in the computer and which is fitted of being activated by an interaction at the plate location in the zone, for controlling the execution of different groups of the computer programs,

the computer is fitted for operating at least one of the following operations:

- a temporization, which neutralize the detection of sound waves for a given time interval after the detection of an interaction of the source and the plate

- good operational tests of a signal acquisition board, by visualizing on the computer screen the place of physical impact on the plate as well as the value of impact counters,
- simulation of the plate operation without using the plate and the acquisition board, by triggering the sequences by using computer mouse that is positioned and activated on desired fields of the digital image of the plate working frame,
- global save of computer files linked to the plate operation (in particular files constituting sequences associated to each of the fields of the plate digital image) according to the following rules:

  a) all files forming a sequence are saved in a directory carrying the field name to which this sequence is associated;

  b) all field directories are located in a unique directory containing in addition the source file,
- a help for the user in the form of a text or an image explaining all possible actions at a given moment when the sequence is in progress of execution or describing means for launching a sequence when the device is in waiting status,
- a statistic module for using the information collected by the computer, and in particular for indicating the number of interactions having been counted for a given period with each zone of the plate working frame,

- complementary means are provided allowing one to trigger for example the plate night lighting or the lighting of a zone of the plate consecutive to a shock to any or predetermined part of the plate working frame,

- transducers constituting each zone are connected to a resistor bridge associated to the sensor before attacking wide band pre-amplifiers of electronic circuits associated with the sensor,

- the plate is made out of glass.

Other aspects, purposes and advantages of the present invention will appear better at the reading of following detailed description of preferred embodiments of this invention, provided as non-limiting example and with reference made to annexed drawings, wherein:

- Figure 1 is a perspective view of a window equipped with sensors and operating according to the principle described in patent WO 96/11378,

- Figure 2 is a schematic cross-sectional view showing two types of impacts perpendicular to the window operated with the same long-limbed object, here a key, maintained differently,

- Figure 3a is a block schema of four identical analog paths for processing signals supplied by the receivers of the window in figure 1,

- Figure 3b is a block schema of an analog processing circuits of one of the four paths in figure 3a,

- Figure 4 is a block schema of connectors, analog circuits, digital circuits for processing signals issued from different electrical nodes of the four paths in figure 3a,

- Figure 5 is a block schema of one part of the internal architecture of the programmed component "wavepro3" in figure 4,

- Figure 6 is a block schema of audio pass-bas filtering circuits of signals issued from pre-amplifier stages of two paths in figure 3a,

- Figure 7 is a schematic cross-sectional axial view of a stiletto according to a preferred embodiment of the invention,

- Figure 8 is a schematic view of an equilibrating electrical circuit of one of the four sensors of the window in figure 1,

- Figure 9 is a block schema of circuits for generating pulse in burst mode at 60 volts for conducting integrity test of the window,

- Figure 10 is a block schema of one part of the internal architecture of the programmed component "wavepro3" designed for generating control signals to transistors of the pulse generator in figure 9,

- Figure 11 is a schematic view of a window showing a doubling of the sensor number, relative to the configuration in figure 1,

- Figure 12 is a schematic view of the window in figure 1, on which the limits of a digital image is superposed and the limits of this image of 640 x 480 pixels coincide with one part of the window, allowing one to make a correspondence between real co-ordinates of an impact point and co-ordinates in pixels of the digital image of the same point.

First, with reference made to figure 1, plate 10 is shown as it was described in patent WO 96/11378. This plate comprises four pairs of piezoelectric transducers SMC1, SMC2, SMC3 SMC4 which constitute each a sound sensor, two transducers of each pair being fixed in opposition on both opposite surfaces of the plate (for example with gluing) to collect sound waves circulating in the plate.

An orthogonal system X, Y with origin O is associated with plate 10, plate center capable of coinciding with origin O of the system. Sensors SMC1 and SMC2 are located on X-axis, symmetrically opposite relative to the origin system. They have as respective co-ordinates $(-X_M,O)$ and $(+X_M,O)$. Sensors SMC3 and SMC4 are located on Y-axis, symmetrically opposite relative to the system origin. They have as respective co-ordinates $(O,-Y_M)$ and $(O,+Y_M)$.

Sound waves may particularly be generated by the shock of an object on the plate. As one can note, they may also be generated by other excitation forms of the plate by a user.

The plate is made out with a rigid material constituting good isotropic acoustic conductor around the 100 kHz frequency, such as the glass. This plate may be flat as in the present embodiment wherein it constitutes a

glass window, but it may also be defined with a curve surface.

The Applicant has observed that the acoustic frequency spectrum of the anti-symmetrical Lamb mode A_0 generated by an object striking the isotropic window, which extends from a few dozens of Hertz to several hundreds of kilohertz, has properties, which depend on the nature and size of the object used for communicating with the window.

So, the more the object striking the window is soft, the less the spectrum contains components in the high frequency range. Thus, if we consider for example a finger of the hand, the spectrum will be different depending on the strike with the skin or the nail of the finger. On the other hand the difference is remarkable in the audible spectrum.

Furthermore, if we consider a hard object such as a metal key, acoustic spectrum will also depend on the way we strike the window, as we will see it with reference to the example in figure 2.

When someone strikes the window with long-limbed key C1 perpendicular to the window surface, acoustic spectrum of waves generated in the window contain less components in the high frequency range than if the shock was produced by inclining the key (key C2).

The reason of this difference is linked to the impact duration. The more the impact has long duration, the more the generated spectrum contains low frequencies. When the long-limbed key, which strikes the window is perpendicular to its surface, impact duration is longer than if the key strikes in inclined position.

In fact, impact duration of an object is linked to transit time of the movement quantity in the object during the strike. A long-limbed object striking perpendicularly the window will be associated to a transit time of a longitudinal sound wave retro propagating along the striking object.

If this object strikes perpendicularly the window but being maintained in inclined position (key C2), window reaction remains

perpendicular and the movement quantity, which is retro propagating in the object by the window reaction lasts the time that a sound wave takes to reach the object limits in the window perpendicular direction, time which is shorter than in the case of a key perpendicular to the window (key C1).

So, it is possible to deduct from the acoustic frequency spectrum generated by the impact, information on the object used by a user for communicating with the window. The Applicant has developed means for using such information to attain the invention purposes.

Interactive window operation of patent WO 96/11378 implies the detection of anti-symmetrical Lamb mode A_0 with sufficiently high ultrasound frequencies for being able to obtain good precision in the detection of sound waves around 100 kHz.

As shown in figure 3a, each window sensor, which delivers respective signal AOPX-, AOPX+, AOPY-, AOPY+, is associate with respective detection electronic circuit D1, D2, D3 and D4. Circuits D1 to D4 are equivalent.

Figure 3b describes principal elements of D1 circuit. This circuit performs wide band pre-amplification, followed with a selective pre-amplification centered on 100 kHz thanks to a selective amplifier IC2G$2 for detecting the fraction of energy generated by an impact at the proximity of this frequency.

This selective amplification is important, because the Applicant has observed that in general this fraction of energy is very weak compared to the recoverable fraction in the audible spectrum in the case of a signal generated by an impact to the window.

Consecutive to this selective amplification centered on 100 kHz, the signal is raised to square by the circuit referenced as IC3, then a crest detection is operated by the reference circuit IC4G$1 and IC4G$2.

Consecutive to this crest detection, the signal is integrated with an

operational amplifier IC5 bringing the output of this amplifier to a positive saturated level obtained with resistor bridges on inverse inputs, to a negative saturated level when the pack of waves is detected.

This transition from a positive saturated level to a negative saturated level on the grid of transistor PMOS T1 has the effect of making it passing as soon as the grid voltage is below 3.5 volts.

Respective outputs XMOINS, XPLUS, YMOINS and YPLUS of circuits D1, D2, D3 and D4 are connected to a computer type processing calculator, through components, which will be described later in this text.

Now we are going to describe different aspects of the invention, which permits one to ensure reliable and ergonomic operation of a window operating according to the principle described in patent WO 96/11378, particularly in an environment comprising acoustic disturbances. For this, we will use the example of a store window equipped with sensors, and to which a user transmits acoustic signals for interacting with a computer connected to the sensors

According to the first aspect, an operational problem linked to the reception of sound waves generated around 100 kHz is the presence of terrestrial noises, issued for example from micro-vibrations of the underground, in this range of frequency. These noises which propagate at the earth surface may be transmitted to the window and excite piezoelectric transducers, this fact may then generates an unexpected detection of sound waves around 100 kHz and disturb the window operation.

However, terrestrial noises have an acoustic spectrum different from the spectrum generated by a user striking the window with his/her nail or a hard object for interacting with a computer connected to the window. Such strike would in fact simultaneously emit sound waves around the 100 kHz and in the audible spectrum. Terrestrial noises have on its own very few spectral components in the audible spectrum (defined in this text as low frequency range).

To avoid that the window is not activated by terrestrial noise, a solution consists of performing a frequency analysis of the detected signal, to verify that a signal detected around the 100 kHz by circuits D1 to D4 also contains frequencies in the audible range. This operation can be performed with known manner starting from the digitalization of the signal and an appropriate processing; for example the study of the discrete Fourier transformed curve of the digitized signal.

A simpler and more economical solution preferred by the invention consists of realizing selective amplification, for example in the proximity of 100 kHz and preferably in the upper limit of the audible spectrum, on one of the four paths issued from respective window, after wide band pre-amplification of the signal.

Figure 4 shows that output BFX- of the wide band pre-amplification stage of the selective amplifier of circuit D1 in figure 3b is adapted to the logic CMOS by commuting transistor PMOS T5. This transistor may validate a control scale for determining if the detected signal contains low frequencies.

In the preferred embodiment of figure 4, if a low-frequency component issued from sensor SNC1 is detected, T5 activates at input clock of counter BF a programmable logic component WAVWPRO3, while signals XMOINS, XPLUS, YMOINS and YPLUS centered on 100 kHz and issued from circuits D1 to D4 are also transmitted to component WAVEPRO3 wherein these signals trigger, as it will be described later in this text, respective scales.

In component WAVEPRO3 whose structure and operation will be described later with reference to figure 5, a logic ET function identifies signals which simultaneously carry an energy in the low-frequency spectrum and also in the spectrum close to 100 kHz, thus permits one to discriminate unexpected triggering of the window due to terrestrial noises.

On the other hand, according to a second aspect of the invention, which can optionally be linked to above aspect, good operation of the

window also implies amplitude quantifying of a spectral component of a sound wave circulating in the window.

In fact, it is possible that an impact to the window is just quite strong to trigger only certain scales respectively associated to four window sensors. In this case, determination of co-ordinates of the impact point on the window is impossible.

It is also possible that a relatively weak signal generated by an impact to the window triggers in the component WAVEPRO3 four scales of four window sensors, but due to the difference of distance between two sensors associated to a same direction and the quadratic integration which is performed on signals delivered by the sensors by respective circuits D1 to D4 after the selective amplification around 100 kHz, an important asymmetry appears in the amplitude of signals of the pair (XMOINS, XPLUS) or of the pair (YMOINS, YPLUS). In this case, determination of impact co-ordinates is also problematic and the window operation is also incorrect.

On the contrary, a violent shock to the window produced for example with a metal object may generate more rapid mode than the A_o mode, particularly the symmetrical mode S_o, and this in sufficient proportion so that device scales commute with this symmetrical mode for which they are not provided. In this case, normal window operation is also disturbed.

Therefore, it is necessary to have a quantitative data of the amplitude associated with an impact to the window, which consist of measuring the signal reverberation in the window consecutive to an impact. Here the reverberation is defined as the necessary time for the signal level to come down again below an amplitude threshold determined consecutive to an impact.

In the particular case of a store window, this time depends first on the shock intensity but also the window size and the absorbent effect of the window holding joints. With constant window size, this time may vary from one window to the other. For a given window, at the moment of the installation of the window and sensors, minimal and maximal reverberations for a correct operation of the window are calibrated.

To quantify the reverberation associated with sound waves consecutive to an impact to the window, one of the respective output signals AMPX-, AMPX+, AMPY-, AMPY+ of selective filters centered on 100 kHz is adapted to logic CMOS with transistor NMOS T6 as it is shown in figure 4, then sent to input clock CLKi of a 12-bit impact counter of component WAVEPRO3.

This counter permits one to record the number of passages with a signal around 100 kHz, of a predetermined amplitude threshold.

It is to be noted that acoustic signal generated by an impact to the window may be detected a first time by the four sound sensors then rebounding on window edges, which constitute the boundary of a solid glass cavity wherein the waves are trapped. Sensors may also detect successive passages of a series of reflected waves issued from the same impact, if the later transmits a large quantity of energy to the window.

Counter CLKi allows one to count for a given impact the total number of threshold passages, whether they are issued from a first series of incident waves or a series of reflected waves, and thus establishing the total quantity of energy associated with the impact. Reverberation time is measured with 12-bit counter by increment of 10 μs.

A variation of this method of measurement of the reverberation at 100 kHz consists of controlling the input clock of impact counter CLKi with a stable clock at 100 kHz, the counting being authorized as long as the successive echo envelope of the wave train generated in the plate at

the proximity of 100 kHz remains above a predetermined threshold.

So, system according to the present invention comprises an impact counter, which permits one to quantify the energy associated with a shock. This information transmitted to the computer to which component WAVEPRO3 is connected may then be used by this computer to generate a signal relating to the impact quality for the user.

So, it is possible for example to use a peripheral connected to the computer for transmitting to a user a light signal indicating to him/her whether the impact is located within desired operational range: green light for an acceptable shock, red light for a too weak or too strong shock.

According to the invention, it may further be advantageous to simultaneously quantify the energy associated with an impact while conducting a spectral analysis such as the one described according to the above-mentioned first aspect of the invention.

In fact, it was said that impacts generated by object with different hardness produce in the window sound waves whose spectral distribution was different. By quantifying energies associated with two or several given frequencies it is possible to determine the nature of material used for striking the window, this fact may be advantageous for example in term of security (such provision would in fact permit the possiblility of triggering a protective preventive action, for example by activating an alarm or by triggering the closing of a metal curtain covering the window, in case of violent shock with a hard object).

With reference made to figure 5, which describes in detail architecture of component WAVEPRO3, a preferred embodiment of the invention consists of using for that two impact counters, one activated by selective filters at 100 kHz (counter CLKi), the other activated by a low frequency filter at 10 kHz (counter BF).

Component WAVEPRO3 operates according to the following logic:

- Four scales FF1 to FF4 associated with four respective sensors of the window may be activated at the level of their input clock by respective signal XMOINS, XPLUS, YMOINS, YPLUS issued from an impact to the window.

- Signs SignX, SignY of impact point co-ordinates are then determined by scales FF5 and FF6. Scales FF1 to FF6 are re-initialized with a writing order to a given address of the board,

- A general 16-bit counter PROCESS COUNTER counting at the clock ck frequency of 1 MHz is activated with detection of a strike by a sensor. This general counter controls chronological steps of co-ordinate acquisition.

Particularly, this counter sends through data transmission bus ISA to the computer a message WrHF of the signal presence in the range of 100 kHz, and these 49.152 ms after the impact. This delay permits impact counters BF and CLKi to have time for quantifying the reverberation at 100 kHz as well as at 10 kHz consecutive to an impact. The message WrHF remains active for 214 clock periods, i.e. 16.38 ms.

- When this message WrHF is perceived by the processing computer, data present on the bus in three states associated with memory addresses are sequentially read by the computer and transformed into pixel co-ordinates on the digitized image of the window according to the protocol, which will be described later,

- Specific programs contained in the computer, whose operational steps will be described later, check the status of a WrHf bit corresponding to the input of impact counter BF. Computer programs thus have signals WrHF and WrBF and may determine whether a trigger of WrHF signal by the WrBF signal optionally corresponds to a terrestrial signal,

- According to a particular embodiment of the invention, when a shock makes WrBF commute and that WrHF does not commute within an interval of pre-defined time after the WrBF commutation, this time

interval, which may be in the order of 70 ms, a computer software deduces from this that the user utilizes an object whose impact to the window generates low frequency waves, but that this object is too soft to efficiently communicate with the window. The computer may then send, through a peripheral such as a projector or monitor. A message to the user recommending the use of a harder object.

According to another aspect of the invention, which can be optionally considered as independent of above-mentioned aspects, the invention proposes to improve the ergonomy and the comfort of window use by extending the communication between the user and the window with interactive mode which does not use a strike. In fact, it may particularly be advantageous to suppress the strike with a hard object to the window, such strikes being not tolerable for example for a merchant having no sufficient place for working in the tranquility at a sufficient distance from the interactive window.

So, according to a first variation of the embodiment, the window is profitably used as a microphone membrane. In fact, if an object striking the window injects energy into the latter at the impact point, the surface receiving this energy, which is however very low, typically in the order of a few dozens of square microns for a key. A person speaking in front of a window emits to the latter a compression wave, which will mechanically excite a much larger surface of the plate window glass.

Excitation of the window then operating on a surface considerably larger than in the case of a punctual impact, it also leads to a detectable signal by the window four sensors. The anti-symmetrical setting of piezoelectric transducer, which is described in patent WO 96/11378, is quite appropriate to the detection of the movement of such wave.

In the case of audible frequencies, for example 1 kHz, wavelength emitted is long compared to the window thickness and the latter acts

as a membrane. Furthermore, piezoelectric disks, which constitute the device sound sensors, have a surface in the order of few square centimeters, which is much smaller than the window excited surface. The more the frequency of the emitted sound wave is reduced, the more the movement amplitude of this membrane and therefore of this signal increases to get close to its fundamental resonance mode, which is located about few hundreds of Hetz for a window of few square meters.

So, a user may communicate with the computer by speaking and by making the window vibrate. As shown in figure 6, the output of at least one wide band amplifier of respective circuits D1 to D4, for example BFX- or BFX+, is deviated by this effect to pass-bas amplifiers, using for example an order 6 Bessel filter, limited to the audible band and designed to adapt in amplitude and in electrical impedance the signal in order to be able to send it to the sound board input via a Jack-type connector.

The signal may also be subjected under certain case to a convolution with multi-polar filter having for the purpose of compensating window selectivity to certain frequencies and obtaining regular response of the window, which acts then as a microphone on a frequency band of few kHz. It is to be noted here that from the practical viewpoint, insertion of a filter at the level of the electronic acquisition board does have an advantage only when a large number of windows of the same size ought to be realized. More conveniently, to adapt the device to varied plate sizes, a software filter integrated into the computer is used.

To audible frequencies that we are interested here, windows are rectangular membranes satisfying to conditions having rigid limits: mechanical movement normal to the glass window is null at the level of joint, which maintains the window edges.

Therefore it is sufficient to reduce the size of the window rigid holding frame to determine transverse resonance frequencies of the glass plate and therefore the glass transfer function. An inverse transfer function, called Wiener filter, is then calculated on a frequency band of few kHz and applied to any audio recording issued from the glass plate.

It is to be noted that stereo recording is possible by associating two sensors, for example sensors SMC1 and SMC2 with two respective audio inputs. In fact, the speed of anti-symmetrical waves in a glass plate is about 3,400 m/s, i.e. 10 times more rapid than the sound speed in air. In other word, sensors SMC1 and SMC2 distant for example of 1.5 meter are equivalent in term of propagation time difference to microphones distant of 15 cm in air. Embodiment of the invention in figure 6 shows a circuit processing two pre-amplified signals BFX- and BFX+.

As extended mechanical and low frequency excitation source, the voice does not permit one to point precise location of the window. But it advantageously completes the ergonomy of a window with which are associated above described detecting and processing means for determining co-ordinates X, Y of an impact to the window.

Above-described variation thus brings an advantageous complement, a specific signal of the voice, which can be triggered, for lighting the window or again for allowing one to leave a local message.

In a second variation, which also permits one to communicate with the window without striking, and which permits one to determine co-ordinates X, Y of a point of the window chosen by a user, it is possible to provide an ultrasound waves generator that the user may silently move in the window surface.

As shown in figure 7, such ultrasound generator may be realized in the form of a stiletto 100 containing longitudinal hollow main body 101, an

electrical energy source 102 located in the body upper part and made up for example with batteries, a generator of continuous burst of pulses and a piezoelectric disk 104 in ceramic, which, excited by the pulse generator when the latter is powered with batteries, put in resonance cavity 105 of the lower part of the body made out with plastic material and filled with liquid anti-freeze 106 having a mechanical impedance comparable to that of material making up cavity 105.

Typically, a polycarbonate cylindrical cavity of about 7 mm high and about 5 mm diameter filled with a standard engine anti-freeze is fitted for generating pulses in the order of 100 kHz.

To transmit this resonance to the window, lower end of cavity 105 opposite to ceramic 104 is mechanically coupled with pellet 107, made out with a material such as silicone, bonded to this closed end of the cavity and whose convex surface offers large mechanical coupling surface with the window.

Mechanical resistance of cavity 105 is provoked by exciting the piezoelectric pellet 104 with an electrical pulse comprising for example a burst of 5 square pulses of 48 volt amplitude, at the cavity 105 resonance frequency, i.e. 100 kHz. Sound waves are transmitted to the window around 100 kHz when the stiletto is maintained in contact with the window by the user at a desired window point.

It is also possible to equip the stiletto with a switch to allow the user controlling the power supply of batteries 102 and therefore the emission of sound waves.

It will be noted that this particular embodiment must preferably be used with a window correctly isolated from terrestrial noises for example a glass mounted on elastomer supports or a glass of a glass door. In fact, a stiletto such as the one described above is not fitted for emitting around

the cavity resonance frequency and does not emit any low frequency wave.

According to another advantageous aspect, which can be considered independently from above-mentioned aspects, the invention also proposes an improvement aiming to the rejection of sound waves propagation symmetrical modes in the window, particularly the mode So.

Window of patent WO 96/11378 already proposes for the elimination of these symmetrical modes to equip each sensor with a pair of transducers mounted in opposition to each other and on both sides of the window glass plate according to a particular mode.

However, an alignment defect 10 of transducer contact surfaces with window 10 (due for example to parallax) changes the efficiency of this arrangement. An advantageous solution for remedying this is to use as piezoelectric transducers the disks whose diameter is large compared to the potential disk error.

As shown in figure 8, thickness difference of adhesive layers 201, 202 that is used to fix respective transducers PZT1, PZT2 of the pair to the window may also disturb the rejection of symmetrical modes. An advantageous solution of the invention is to use variable resistor bridge, such as the one in figure 8 to adjust the relative gain of two piezoelectric disks of the same sensor.

Another characteristic of the invention relates to the addition of functions allowing one to check the plate status, which constitutes the interface (integrity of glass plate, of bonding and the state of electrical connection of piezoelectric sensors).

To do this, one of the four piezoelectric receivers (for example YPLUS) is commuted into a transmitter that is excited by an electrical pulse in burst mode at 100 kHz. Then, propagation time t_{y+y-} and $t_{y+x-} - t_{y+x+}$ is measured (t_{ab} being the difference of receiving time of sensors a and b), as well as the reverberation (status of impact counter at 100 kHz)

and these values are compared with reference values, which have been recorded at the window installation time. In case of difference greater than a predetermined threshold, an alarm may be triggered or a protective curtain shut down by the computer.

From a practical viewpoint, integrity control of the window is done at the start of the device and then at each time that the computer launches a multimedia sequence, i.e. just after a shock to the window.

For this, a relaxation oscillator built with an operational amplifier IC22 of figure 9 powers diode pump and capacitors C123, C124, C127, C128, C129, C130, D2S1, D2S2, D2S3, allowing one to obtain a voltage of 60 volts at the reservoir capacitor terminals C126 and C131. Value of reservoir capacitors is large compared to that of static capacitors in ferro-electrical ceramics. A voltage close to 60 volts may then be applied to the terminals of one of the piezoelectric transducer pairs in the form of a burst of 100 kHz obtained with a sequence of specific controls of transistors T7, T13, T8, T14, T9, T10, T11, T15 issued from component "WAVEPRO3".

To trigger the integrity test, the computer sends a writing order to board +1 address. (Example, if the address of the board is H300, a writing order is sent to address H301).

This writing order is manifested by a change of the bit status of the address bus as well as bits status of WRB, AEN of bus ISA, as shown in figure 10. These bits arrive at the input of component "WAVEPRO3", which decodes these statuses and activates an internal bit used as clock input to scale FF7.

Always with reference made to figure 10, writing to board +1 address that locks scale FF7 in state 1 validates the start of general counter "PROCESS COUNTER". Combinatory logic on output bits of general counter allows one to define the electrical pulse duration in burst

mode that will be applied to transducer pair "YPLUS".

For example, a logic ET at the last 10 significant inverse bits of the general counter remains at high state during the sixty-four first microseconds of the general counter. Output of this logic ET called "timburs" validates the starting during the 64 µs of an relaxation oscillator of 100 kHz built from external components R130, R129, C159 and gates INV1 and NAND1 and creates a burst of 7 periods in HCMOS logic. This burst called "7F100" powers the grids of transistors NMOS T17 and T13 of figure 9, these transistors controlling themselves by becoming passing of PMOS T9 and T12.

With reference made to figures 9 and 10, inverse logic SINK of this burst powers the grids of transistors NMOS T8 and T14 in charge of absorbing discharge current from the transducer pair "YPLUS". Resistor R95 allows one to avoid that leaking current of transistors PMOS T9 and T10 does not charge the piezoelectric transducer pair "YPLUS".

In order to avoid that the burst of 60 volts does not damage amplifiers of the analog path "YPLUS", transistors NMOS T10 and T11 are maintained in blocked state (high impedance) and T15 at passing state (low impedance) for the entire pulse duration.

For that, it is enough to apply the signal "timburs" to the grid of transistor T15 and its inverse logic timbursb, which commutes at high level and not at the 64th period of clock ck but at the 65th (thank to function NAND on bit Q6 combined with output of an AND on inverse bits Q0 to Q5). This fact allows one to keep transistors T10 and T11 blocked during an additional clock ck period relative to the duration of the burst, and avoid high voltage glitches at the input of amplifying path YPLUS.

Once electrical excitation of the transducer pair "Yplus" is done, the device waits for the arrival of wave pack on the other three paths and performs classical measurement of the propagation time difference t_{y+y-}

and ($t_{y+x-} - t_{y+x+}$) and the relaxation time at 100 kHz in the glass plate. Then a classical general reinitializing order is sent to the board address in order to put the device in waiting state for a mechanical shock.

The process, which was just described, is a preferred process of the present invention because it avoids bonding the additional piezoelectric transducers dedicated to the task of conducting the window integrity test. On the other hand, it is also possible to bond to the window transducers dedicated to this test.

Particularly, it is possible to anticipate the bonding of transducers to lower right and left corners of the window, this fact leads to a larger coverage of the window surface during the integrity test. In this case, the excitation of transducers is sequentially done, and their identification is conducted with the decoding of a value of the data Bus attributed to each of the transducers.

A doubling of the number of transducer pairs allows one not only to have better coverage of the window surface during the integrity test, but also an improvement of the measurement precision at window corners. When this option is chosen, the four pairs of additional transducers also form a diamond of 45° from the first transducer as indicated in figure 11. A simple math transformation permits one to make the changes of references.

The system according to the invention comprises a computer, which receives signals issued from processing electrical circuits. The computer may, in function of these signals, controls the execution of files contained in the computer with various known-type peripherals connected to the computer such as for non-limiting example: video projector, light sources, loud-speakers, printer or again an automated box controlling mechanical action such as the closing of a window curtain.

The window then constitutes an interface whose one "active" part called "working frame" may specifically be activated by a punctual shock

to a precise (X, Y) location, different zones of the window working frame permitting the execution of different respective program groups of the computer.

To ensure such system operation, wherein the window working frame is equivalent to the computer screen on which it is possible to click on different locations with a mouse, it is necessary to associate each point (X, Y) of the window to a pixel on the computer screen.

For that, following operations are performed. They are described in figure 12. With reference made to this figure, following symbols will be used:

X_r = real Cartesian co-ordinate X of the impact calculated with the help of sensor position relative to origin O of reference point X_1, Y_1

Y_r = real Cartesian co-ordinate Y of the impact calculated with the help of sensor position relative to origin O of reference point X_1, Y_1

L = real width of the working frame in mm,

l = real height of the working frame in mm,

N_{cX}, N_{cY} = co-ordinates in pixel of the working frame center,

C = working frame center,

O = origin of real co-ordinates.

- Origin O of X, Y co-ordinates of the window is visually marked, for example by applying to this point a color adhesive pellet or a piece of adhesive tape,
- A digital image of 640 x 480 pixels including the origin O is drawn. This digital image may be realized by taking a photograph with a digital apparatus or by digitizing a photograph of the window,
- On the computer, desired working frame is then drawn correspondingly to the window zone, which will be activated by a user,

- Working frame size in pixels is deduced from this drawing. In the example of figure 11, length L in X direction corresponds to 309 pixels (N_{maxX}) and the height l in the Y direction corresponds to 257 pixels (N_{maxY}).

- Then a homothetic correspondence is established; this similarity provides the working frame scale. In the example of figure 11,309 pixels correspond to 1,400 mm which is the physical length L of the working frame on X direction and the physical width l of this working frame, which is 1,164 mm corresponds to 257 pixels.

- On the computer, the cursor is pointed to point O which is the origin of real co-ordinates X, Y of the window and which is visually referenced and co-ordinates of this point is deduced into pixels. Co-ordinates of origin O may be positive or negative, point O being not necessarily comprised in the window working frame; however, this point O origin of real co-ordinates of points in the window ought to be on the window digital image.

Considering any point q of the working frame and belonging to a zone i, q co-ordinates are N_{xq}, N_{yq} as defined by following formulas:

with

k_x and k_y are coefficients equal to +1/-1. They allow one to change the axis directions. Particularly, possible error during cabling of sensors consists of an error on the direction of X-axis. For referencing a passer-by in the street, a click on positive X (i.e. to the right of the window when the window is seen from the street) corresponds to a click to the left of the window when the window is seen from inside the store.

By definition, axis of positive X is that of the street, i.e. to the right of the window when it is seen from the street while in standing position.

In the above formulas, Δt_x and Δt_y respectively correspond to the difference of arrival time of a sound wave generated by a shock at point q of two respective sensors of direction X and direction Y, and √ is the sound wave speed in the plate. It is noted that four sound sensors are not necessarily placed on the window edge.

Once this correspondence established, it is then possible to define a partition of the window working frame into several zones; each zone corresponds to a field of the window digital image, which is stored in the computer and which controls the execution of a predetermined sequence of programs by various above-mentioned peripherals.

It is obviously possible to organize at will sequences associated with a given field of the digital image. So, one may associate an executable program or several executable programs with a given field, program (or programs) which may be triggered successively or simultaneously and capable of using one or several peripherals.

According to an advantageous characteristic of the invention, which improves its ergonomy and reliability of its operation, it is also possible to provide in the computer software a temporizer, which neutralizes the detection of sound waves for a given time interval after the detection of an impact. Such temporizer permits one to avoid the detection of two successive impacts, which can be generated by the rebound of an object used for activating the window.

Neutralization time of the reception could be for example in the order of 300 milliseconds; the Applicant having observed that such physical rebounds of a hard object on a glass plate were produced in general 50 to 100 milliseconds after the initial impact.

According to the invention it is also possible to provide tests of the system good operation:

- Thus, it is possible to check the signal acquisition board operation by visualizing on the computer screen the physical impact location on the window. This visualization allows one to check good geometrical positioning of the point corresponding to the impact point on the window digital image and to particularly detect any shifting or error of scale.
- Moreover, it is also possible to display a parameter quantifying the energy associated with an impact in order to make a calibration for determining the desired impact intensity range corresponding to a good operation of the window.

It is also possible to conduct simulation of the window operation without using the window and the acquisition board, by triggering the sequences with the computer mouse that is positioned and activated on desired fields of the digital image of the window working frame.

Other advantageous functions of the system according to the invention include:

- Global saving of files linked to the window operation (particularly files constituting sequences associated with each of the fields of the window digital image). In fact, it is necessary, once the window is completely defined, to globally save all data in a specific directory of the computer disk according to following rules:
    - All files forming a sequence are saved in a directory carrying the name of the field to which this sequence is associated with,
    - All field directories are located in a unique directory containing in addition the source file (.VIS) and the other necessary files (statistic file that will be mentioned later, image by default). This

directory carries the same name as that of the source file.

So, a window is perfectly defined with the knowledge of a unique directory (easiness for saving, transferring and recovering).

The content of this unique directory may then be transferred to the hard disk directory of a computer identified in a network; connection to remote computer may be done via a modem.

It is also possible to supply an aid to the user in the form of a text or an image explaining all possible actions at a given moment when the sequence is in progress or describing the means for launching a sequence when the system is on waiting status. This text or this image may be shown at the lower part of the computer screen and may also by projected with a peripheral in the form of a luminous image on a screen associated with the window or on one part of the window itself.

It is also possible to display, always on the computer screen and/or at the proximity or on the window, an image by default to show a potential user practical example for the use of the system, consisting for example of a person photograph using the window..

It is also possible to provide a statistic module for using information collected by the computer, and particularly indicating the number of impacts having been received for a given period by each zone of the window working frame. For example, in the context of a commercial operation, this information collection would permit the window owner to know the interest revealed by different window zones. This follow-up may be directly conducted by constantly displaying the number of impacts received by each zone.

It is also possible, within the scope for example of a store window, to switch-off all window lighting by night and then program the computer to trigger the window lighting consecutive to a shock on any or predetermined part of the window working frame.

Finally, it is possible to extend the system functions by providing for example additional system for communicating with the user, such as for example a keyboard thanks to which a user may input a certain number of information for recording, for asking additional information or again for identification consecutive to a recording and then for asking reserved information.

Such identification system is an efficient alternative to the above-mentioned voice recording means when environmental noise does not allow the use of such sound recording means.

CLAIMS

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1. Device for acquiring co-ordinates of interaction points of an acoustic source with the surface of a plate (10) having finite dimensions comprising a set of sound sensors (SMC1 to SMC4) each formed with a pair of piezoelectric transducers (PZT1, PZT2) located in opposition on both side of the plate, the device comprising processing means for determining co-ordinates of said interaction point with analysis of the difference of propagation time of sound waves emitted by the source to different sensors, device characterized by the fact that processing means comprise in association with each sensor (SMC1 to SMC4) a respective electronic circuit (D1 to D4) comprising in cascade means for performing wide band pre-amplification, and means of selective amplification (IC2G$2) centered on a first predetermined frequency.

2. Device according to claim 1 characterized by the fact that sensors are in the number of four and piezoelectric transducers of each sensor are piezoelectric ceramic disks bonded to both sides of the plate, such that four sensors form on the plate the apexes of a diamond whose center constitutes the origin (O) of co-ordinates.

3. Device according to claim 1 or claim 2 characterized by the fact that said first predetermined frequency is in the order of 100 kHz and said centered selective amplification means comprise a selective amplifier (IC2G$2) for detecting the fraction of energy generated by the source at the proximity of said first predetermined frequency.

4. Device according to claims 2 and 3 characterized by the fact that localization of an interaction point of the source on the plate, consists of extracting the ultrasound frequency component at the proximity of 100 kHz generated by the impact of a hard object such as finger nail, metal key, ball-point pen, hard plastic material and determining on the one hand the difference of propagation time between two sensors of the first pair (SMC1, SMC2) and on the other hand two sensors of a second pair (SMC3, SMC4), such that Cartesian co-ordinates of the impact point (x_r, y_r) on the plate are provided by the formula:

wherein x_M and y_M designate the sensor position relative to the origin (O) of the diamond, √ the speed of anti-symmetrical Lamb mode in the plate, Δt_x (respectively Δt_y) the difference of propagation time of the wave pack generated by the impact between sensors of the first pair (SMC1, SMC2) and respectively of the second pair (SMC3, SMC4)), k_x (respectively k_y) a coefficient equal to +1 or −1 and sign(x_r), sign(y_r) the signs of co-ordinates x_r and y_r.

5. Device according to claims 1 to 4 characterized by the fact that said electronic circuits (D1 to D4) associated with respective sensors (SMC1 to SMC4) comprise in cascade a wide band preamplifier stage, a square integration stage (IC3), a crest detector stage (IC4G$1, IC4G$2), an integrating stage (IC5) and an adaptation to a logic level stage.

6. Device according to claim 5 characterized by the fact that said logic level is of the CMOS type.

7. Device according to claims 1 to 6 characterized by the fact that electronic circuits (D1 to D4) associated with respective sensors comprise upstream said selective amplification means, a derivation (BFX-) toward analyzing means of at least another spectral component for characterizing the nature of the acoustic source or the source size.

8. Device according to claim 7 characterized by the fact that analyzing means comprise at least a selective pass-band filter individually centered on a predetermined centering frequency different from said first predetermined frequency, and processing means comprise downstream said electronic circuits associated with respective sensors, a programmable logic module (WAVEPRO3).

9. Device according to claim 8 characterized by the fact that said predetermined centering frequency is located in the audible spectrum, preferably in the upper limit of audible spectrum.

10. Device according to claim 8 or 9 characterized by the fact that said programmable logic module comprises a logic component fitted for determining whether a signal generated by the source in the plate comprises significant components simultaneously around the first predetermined frequency and around the centering frequency (or frequencies).

11. Device according to any one of previous claims characterized by the fact that means are provided for determining the intensity of a signal transmitted by the source to the plate around the first predetermined frequency.

12. Device according to claim 11 characterized by the fact that said means for determining the intensity comprise means for measuring, in the form of reverberation, the number of echoes on the plate edges of a sound wave generated around the first predetermined frequency by an interaction of the source with the plate.

13. Device according to claim 12 characterized by the fact that a 12-bit counter (CLKi) is provided for measuring the reverberation; this counter is powered by output (AMPX-, AMPX+, AMPY-, AMPY+) of selective amplification means centered on the first predetermined frequency issued from one of the sensors and adapted to logic CMOS.

14. Device according to claim 13 characterized by the fact that impact counter (CLKi) is activated by a stable clock, the counting being authorized as long as the envelope of successive echoes of the waves pack generated in the plate at the proximity of the first predetermined frequency remains above a predetermined threshold.

15. Device according to claims 12 to 14 characterized by the fact that means are also provided for determining the intensity of a signal transmitted by the source to the plate at least around one centering frequency different from the first predetermined frequency.

16. Device according to claim 15 characterized by the fact that at least another counter (BF) is provided; this counter is individually associated to a centering frequency and fitted for counting the number of echoes on the plate edges of a sound wave generated around said associated centering frequency by an interaction of the source with the plate.

17. Device according to claim 15 or claim 16 characterized by the fact that means are provided for determining the nature of the source in function of the intensity of signal transmitted from the source to the plate around the first predetermined frequency and the centering frequency (or frequencies).

18. Device according to any one of the claims 11 to 17 characterized by the fact that means are provided for sending to a user a luminous message via a peripheral connected to processing means, information to him/her whether an interaction has generated a sound signal in the desired reverberation range.

19. Device according to any one of the claims 11 to 18 characterized by the fact that according to a threshold value attained by one or several counters individually associated each with a frequency, the device is fitted for triggering preventive actions for the plate security, for example by activating an alarm or triggering the closing of a metal curtain covering the plate.

20. Device according to any one of previous claims characterized by the fact that the source is capable of exciting the plate without having said plate transmitted sound waves to ambient environment.

21. Device according to claim 20 characterized by the fact that the source is a stiletto (100) whose hollow longitudinal main body (101) comprises an electrical energy source (102), an electrical pulse generator (103) fitted for being powered by the electrical energy source, a piezoelectric ceramic disk (104) fitted for being excited by the pulse generator to bring the main body cavity (105) in longitudinal resonance, which is filled with a component having mechanical impedance comparable to that of a material constituting the main body, said main body cavity

being closed with a pellet (107) made out with a soft material having impedance comparable to that of silicone.

22. Device according to claim 21 characterized by the fact that the electrical pulse generator is fitted for continuously emitting burst of pulses around 100 kHz and the hollow main body is made out with a material entering into resonance around this frequency, for example a plastic material.

23. Device according to claim 21 or claim 22 characterized by the fact that the component filling said main body cavity is a liquid anti-freeze (106).

24. Device according to claims 21 to 23 characterized by the fact that the stiletto comprises a power switch for controlling the emission of sound waves.

25. Device according to claims 1 to 19 characterized by the fact that the plate is fitted for being excited with a compression wave generated by the user's voice, and the output of wide band pre-amplification stage (BFX-, BFX+) of at least one of the electronic circuits associated with respective sensors is directed to pass-bas amplifiers, for example order-6 Bessel filters limited to audible band.

26. Device according to claim 25 characterized by the fact that said pass-bas amplifier output is sent to an output connector of the stereo Jack type and then to an audio acquisition board.

27. Device according to claim 25 or claim 26 characterized by the fact that one or several electronic band-cutting filters are inserted

downstream the pass-bas filters to compensate the plate own resonance at certain frequencies.

28. Device according to claims 25 to 27 characterized by the fact that it comprises a software filter with inverse transfer function of the electrical acoustic frequency response of the plate to a given frequency band of a few kilohertz, for processing audio signals issuing from the glass plate.

29. Device according to any one of previous claims characterized by the fact that one of the sensors is fitted for being commuted into transmitter of an ultrasound waves pack in order to trigger an integrity test of the plate comprising the measurement of:

- difference of propagation time (t_{y+y-}, $t_{y+x-} - t_{y+x+}$) of the waves pack between different sensors,
- and the reverberation of the wave pack thanks to impact counter,

and the device comprises means for comparing said reverberation value to reference values and means for triggering preventive actions for the plate security, for example by activating an alarm or closing a metal curtain covering the plate.

30. Device according to claim 29 characterized by the fact that integrity test is triggered by a writing instruction to a memory address, starting a general counter and an oscillator (R130, R129, C159) from which a logic burst (SOURC) and its inverse logic (SINK) are fitted for activating the grids of electrical components controlling the adaptation of logic burst to a higher voltage applied to sensor commuted into transmitter, said higher voltage being obtained with the help of the oscillator and a diode pump connected to the reservoir capacitors (C126, C131).

31. Device according to claim 30 characterized by the fact that the oscillator is relaxation oscillator operating at about 100 kHz, said higher voltage is in the order of 60 volts and said electronic components are NMOS (T7, T13, T8, T14) and PMOS (T12, T19) transistors.

32. Device according to claim 30 or claim 31 characterized by the fact that input stage (AOPY+) of the electronic circuit associated with a sensor commuted into a transmitter is protected from high voltage burst by commutation transistors NMOS (T11, T18) blocked during the burst and passing when the sensor fitted for being commuted into a transmitter is in receiving mode.

33. Device according to any one of claims 29 to 32 characterized by the fact that plate integrity test is conducted at the start of the device and just after an interaction between the source and the plate.

34. Device according to any one of claims 29 to 33 characterized by the fact that additional transducer pairs are dedicated to integrity test.

35. Device according to claims 2 and 34 taking in combination, characterized by the fact that additional transducer pairs are also in the number of four and define a second diamond directed at 45° relative to the sensors diamond, additional transducer pairs also participating to the measurement of co-ordinates of interaction point between the source and the plate.

36. Device according to any one of previous claims constituting peripheral interface with a machine, which receives signals issued from

processing means, and which in function of said signals controls the execution of files contained in the computer by various known type peripherals connected to the computer such as for non limiting example: video projector, light sources, loud-speakers, printer, or again an automated box controlling a mechanical action such as the closing of a protective curtain.

37. Device according to claim 36 characterized by the fact that said machine is a computer equipped with a screen.

38. Device according to claim 37 characterized by the fact that a pixel of co-ordinates N_{cX}, N_{cY}) at the computer screen showing an image of the plate is associated with a physical point of the plate of co-ordinates (x_r, y_r), the conversion of co-ordinates comprising following operations:

c) visual marking center (O) of sensors,

d) recording a digital image including the origin (O),

e) delimiting on digital image a working frame with center C, and calculation of the length (N_{maxX}) and the height (N_{maxY}) in pixels of the working frame,

f) definition of a homothetic correspondence which provides the working frame scale, i.e. the length L and the height l in millimeters corresponding to the working frame drawn on the plate,

g) positioning on digital image a cursor pointing on the sensor center, i.e. on the origin of real co-ordinates (x_r, y_r) of the plate, visually referenced in a),

such that any pixel (q) of co-ordinates N_{xq}, N_{yq} of the working frame will be connected to its real co-ordinates (x_r, y_r) according to the formula:

39. Device according to claim 38 characterized by the fact that one portion of the plate which defines a working frame equivalent to the computer screen is divisible into zones of any form, each zone corresponding to a field of the plate digital image which is stored in the computer and which is fitted for being activated by an interaction at a plate location (x_r, y_r) belonging to the zone, for controlling the execution of different computer groups of programs.

40. Device according to claims 37 to 39 characterized by the fact that the computer is fitted for making at least one of the following operations:

- temporization which neutralizes the detection of sound waves for a given time interval after the detection of an interaction between the source and the plate,
- tests of good operation of the signal acquisition board, by visualizing on the computer screen the physical impact location on the plate as well as the value of impact counters,
- simulation of the plate operation without using the plate and the acquisition board, by triggering sequences with a computer mouse that is positioned and activated on desired fields of digital image of the plate working frame,
- global saving computer files linked to the plate operation (particularly

files constituting sequences associated with each of the fields of the plate digital image) according to following rules:

a) all files forming a sequence are saved in a directory carrying the name of the field to which this sequence is associated with,

b) all field directories are located in a unique directory containing in addition the source file,

- assistance to the user in the form of text or image explaining all possible actions at a given moment when the sequence is in progress or describing means for launching a sequence when the device is in waiting state,

- a statistic module for using information collected by the computer and particularly indicating the number of interactions having been done during a given period with each zone of the plate working frame.

41. Device according to any one of previous claims characterized by additional means allowing one to trigger for example the plate night lighting or the lighting of a plate zone consecutive to a shock on any or predetermined of the plate working frame.

42. Device according to any one of previous claims characterized by the fact that constituting transducers of each sensor (SMC1 to SMC4) are connected to a resistor bridge associated with the sensor before attacking the input (AOPX-, AOPX+, AOPY-, AOPY+) of wide band preamplifiers of electronic circuits associated with the sensor.

43. Device according to any one of previous claims characterized by the fact that the plate is made of glass.

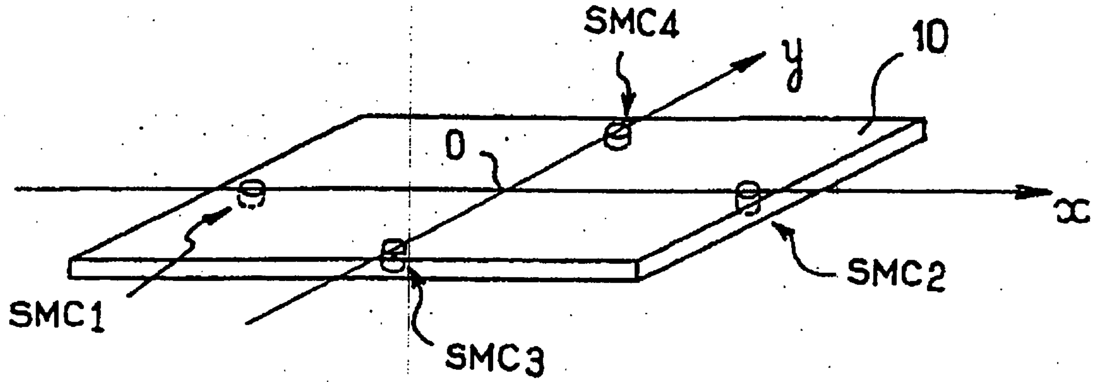


FIG_1

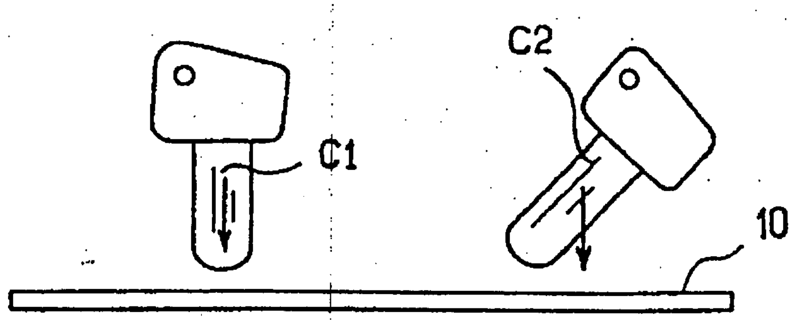


FIG_2

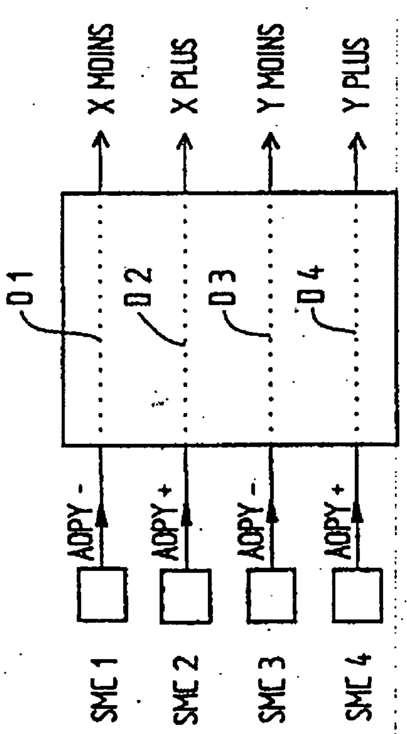

D 1
D 2
D 3
D 4
ADPY -
ADPY +
ADPY -
ADPY +
SME 1
SME 2
SME 3
SME 4
X MOINS
X PLUS
Y MOINS
Y PLUS

FIG.3a

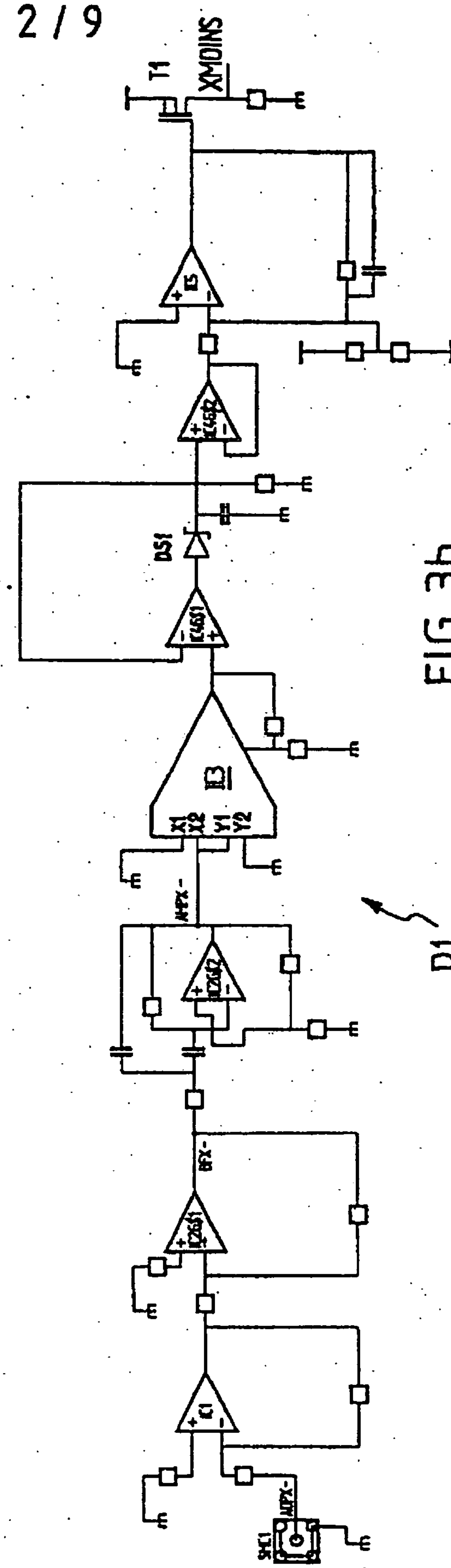

T1
XMOINS
IC5
IC4682
DS1
IC4681
IC3
X1
X2
Y1
Y2
AMPX -
IC2682
BFX -
IC2681
IC1
ADPX -
SME1
D1

FIG.3b

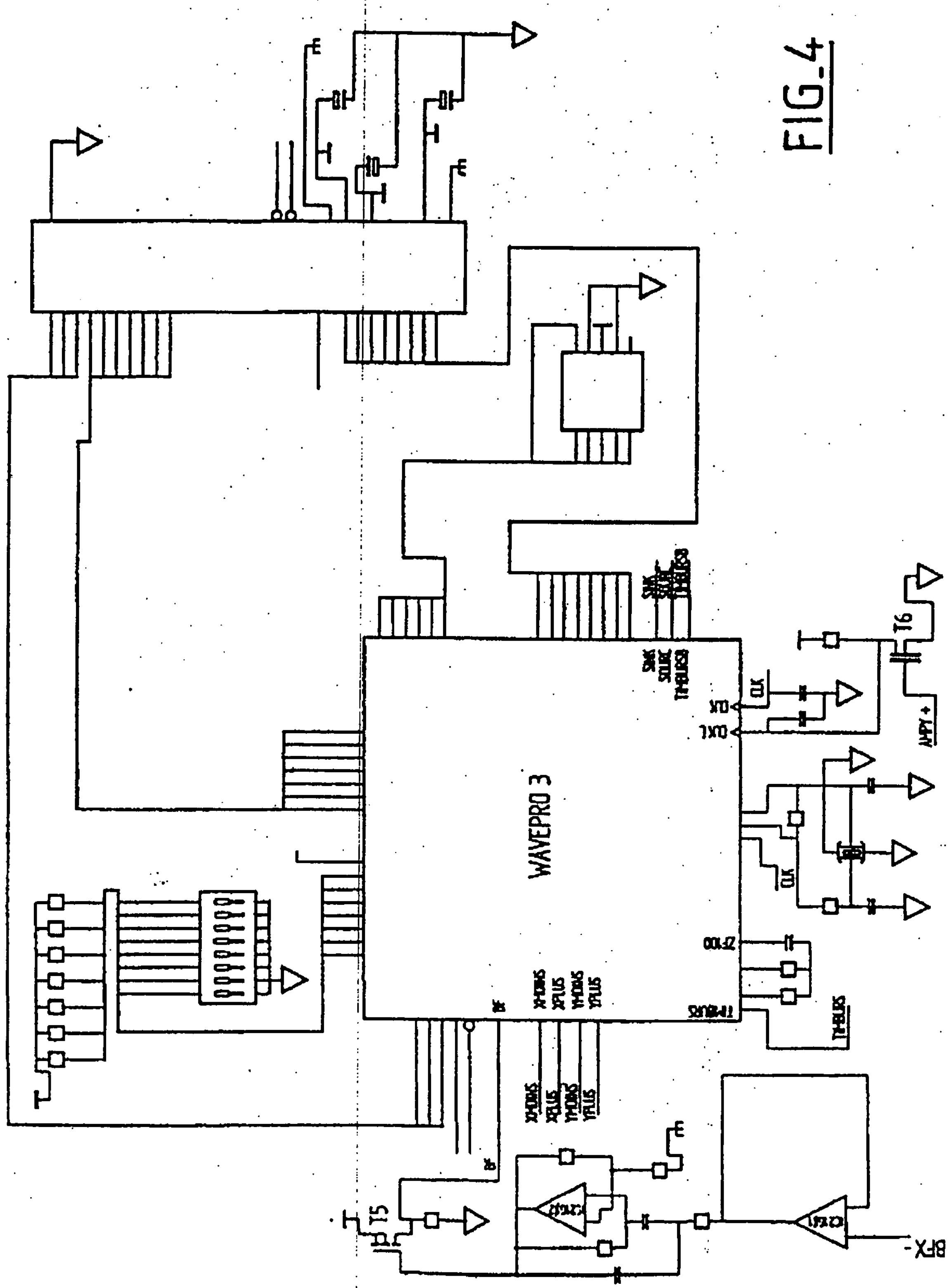
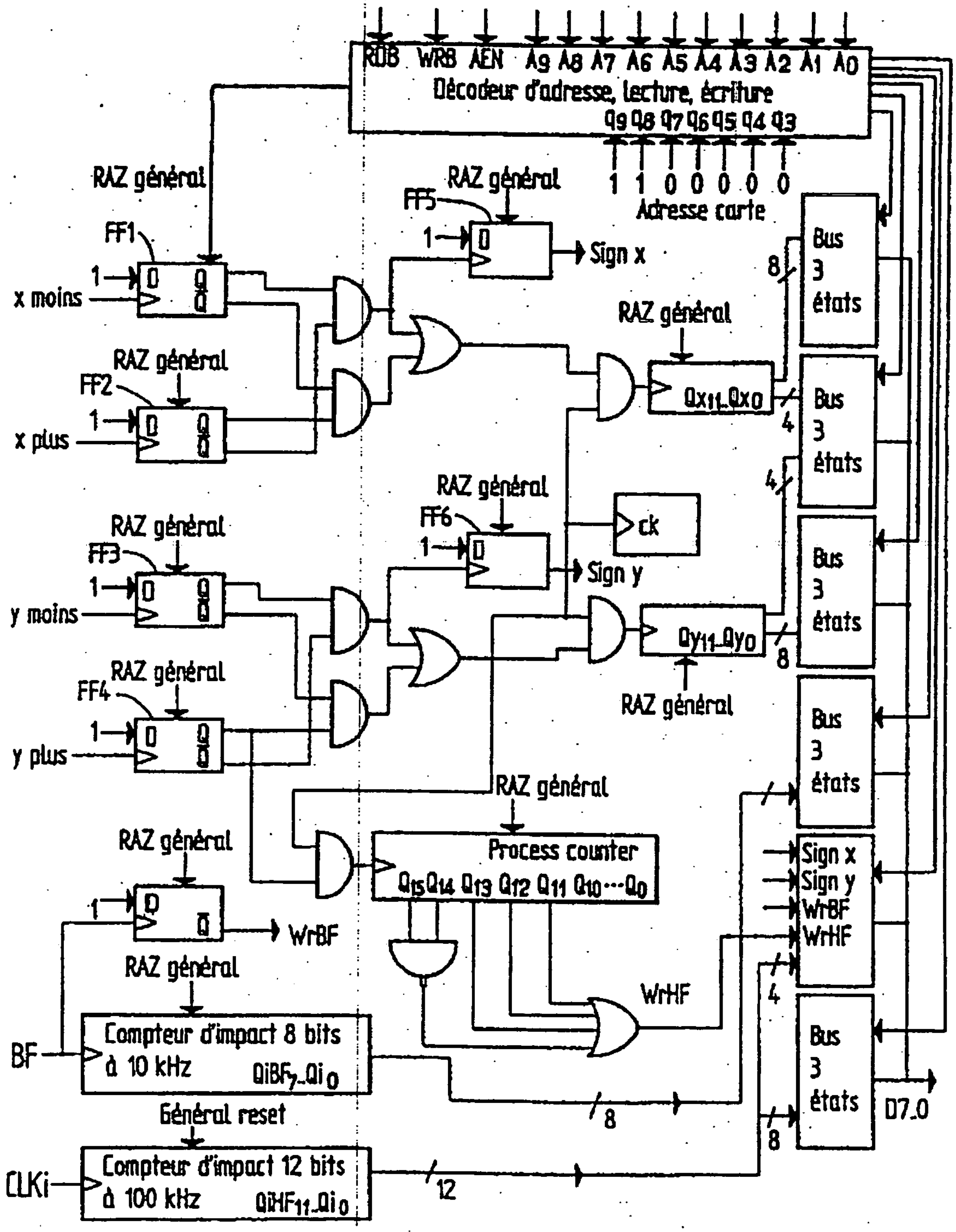


FIG_4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Décodeur d'adresse, lecture, écriture
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1 1 0 0 0 0 0
Adresse carte
RAZ général
FF1
FF2
FF3
FF4
FF5
FF6
x moins
x plus
y moins
y plus
Sign x
Sign y
ck
Qx11 Qx0
Qy11 Qy0
Bus 3 états
Process counter
Q15 Q14 Q13 Q12 Q11 Q10 ··· Q0
WrBF
WrHF
Compteur d'impact 8 bits à 10 kHz
QiBF7 Qi0
Général reset
Compteur d'impact 12 bits à 100 kHz
QiHF11 Qi0
BF
CLKi
D7.0
8
4
12

FIG. 5

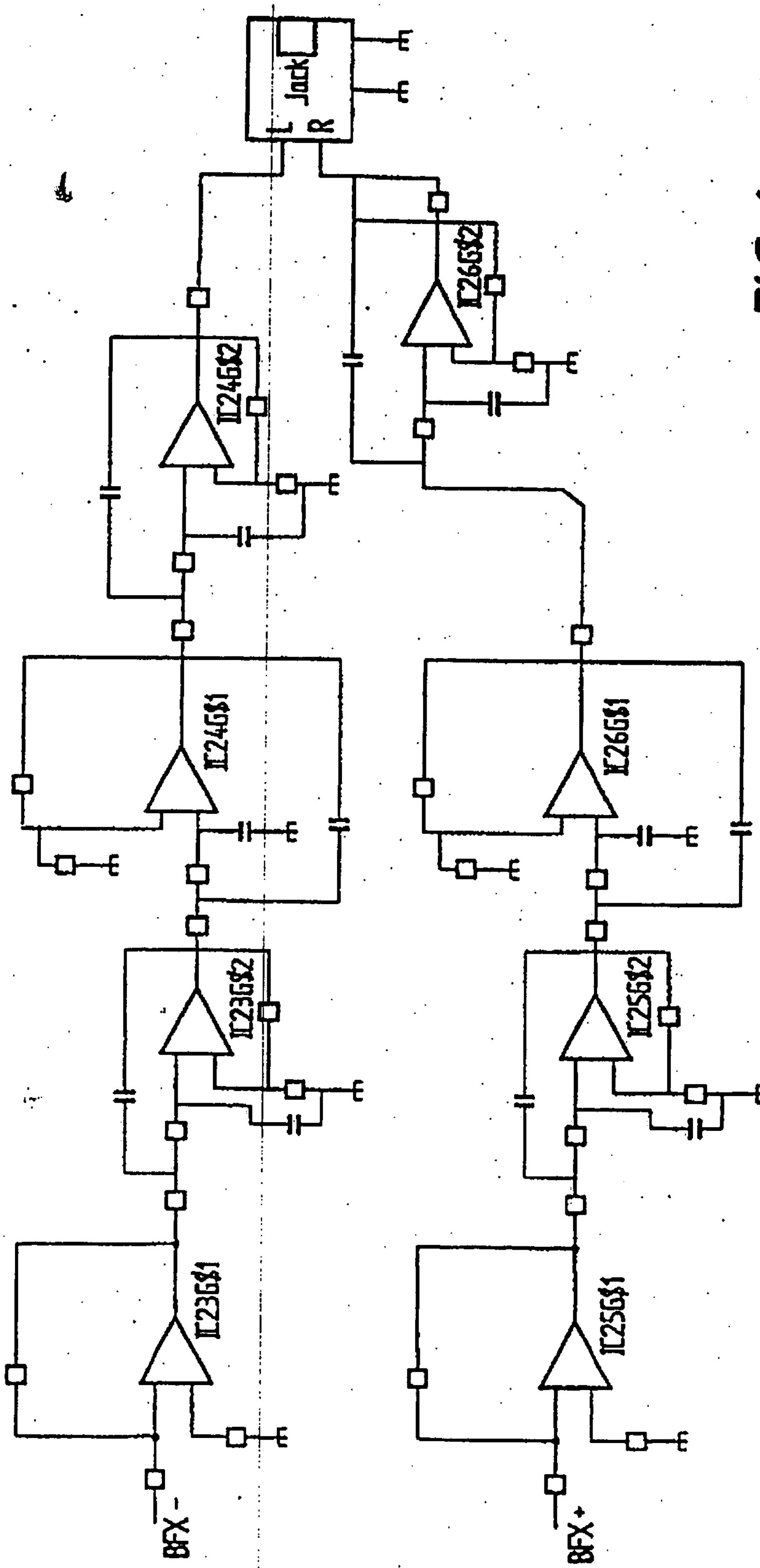

Jack
L
R
E
IC24G$2
IC26G$2
IC24G$1
IC26G$1
IC23G$2
IC25G$2
IC23G$1
IC25G$1
BFX -
BFX +

FIG. 6

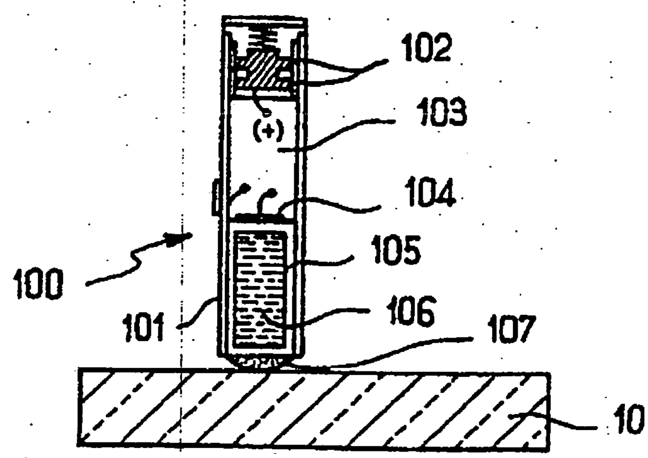
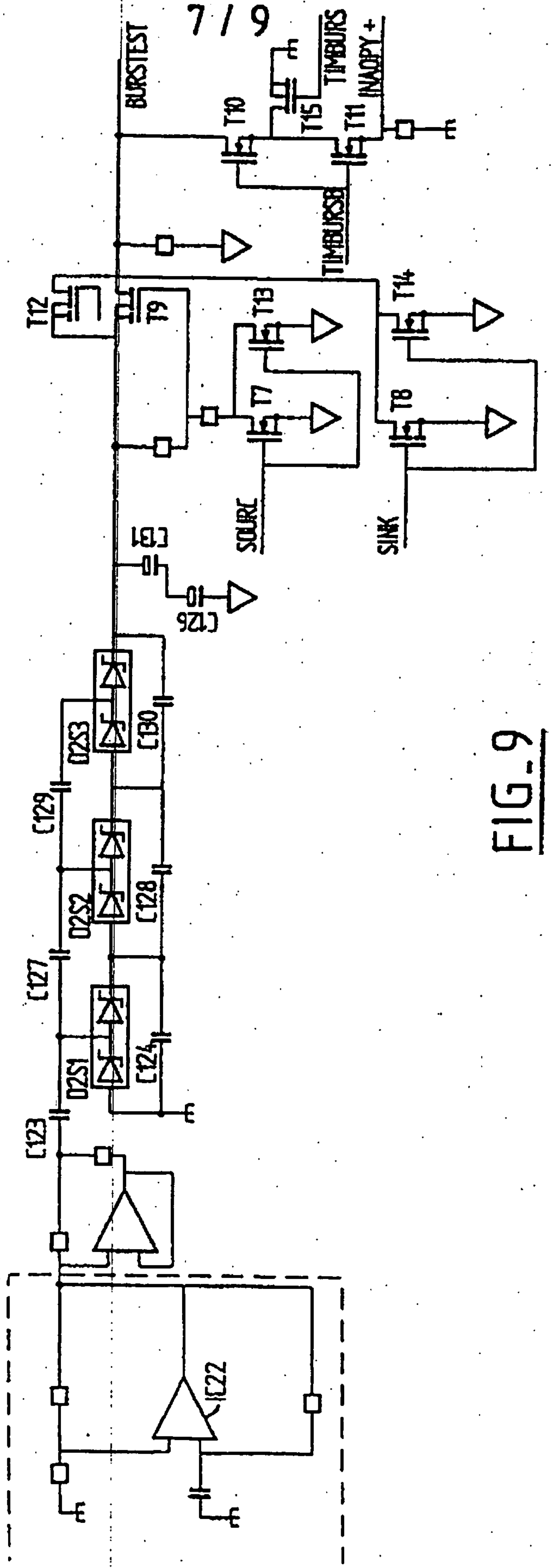


FIG_7



BURSTEST
TIMBURS
INADPY +
T10
T15
T11
TIMBURSB
T12
T9
T13
T7
T14
T8
SOURCE
SINK
C131
C126
D2S3
C130
C129
D2S2
C128
C127
D2S1
C124
C123
IC22

FIG_9

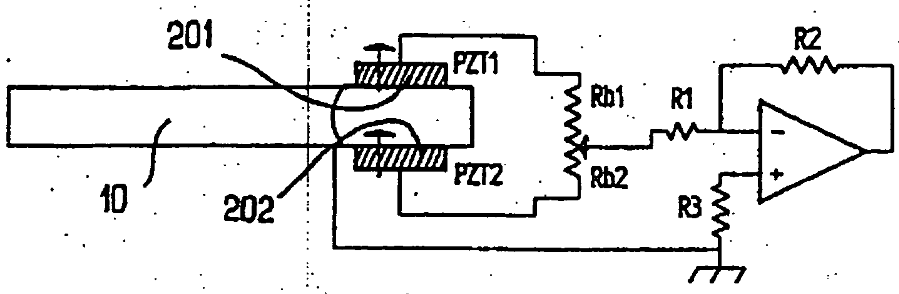

201
PZT1
PZT2
Rb1
Rb2
R1
R2
R3
10
202

FIG_8

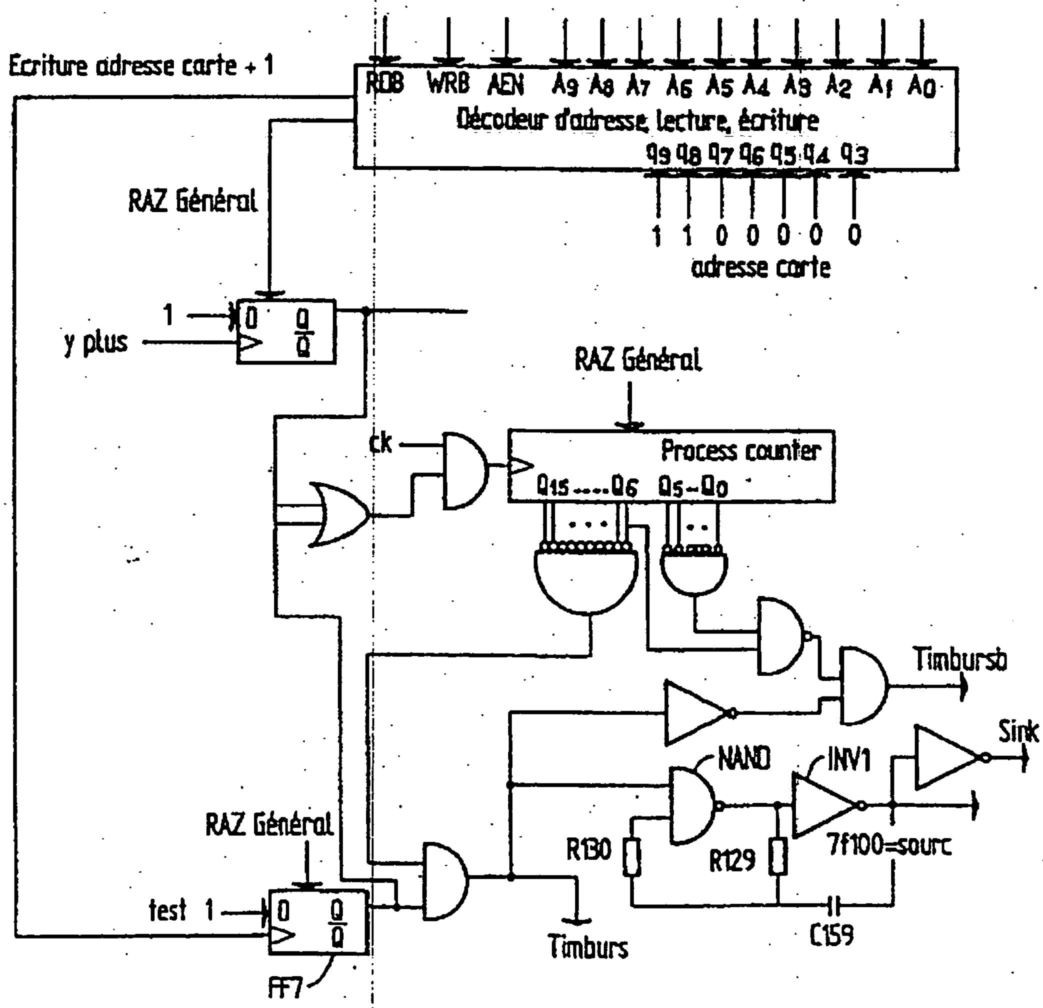

Ecriture adresse carte + 1
RDB WRB AEN A9 A8 A7 A6 A5 A4 A3 A2 A1 A0
Décodeur d'adresse, lecture, écriture
Q9 Q8 Q7 Q6 Q5 Q4 Q3
1 1 0 0 0 0 0
adresse carte
RAZ Général
1
y plus
RAZ Général
ck
Process counter
Q15 ..... Q6 Q5 .. Q0
Timbursb
NAND
INV1
Sink
R130
R129
7f100=sourc
C159
RAZ Général
test 1
FF7
Timburs

FIG_10

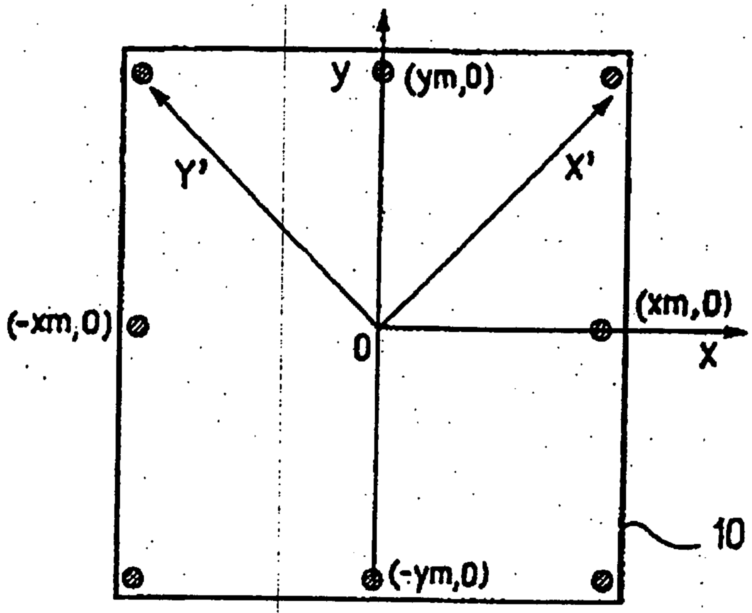

y
(ym,0)
Y'
X'
(-xm,0)
0
(xm,0)
X
10
(-ym,0)

FIG_11

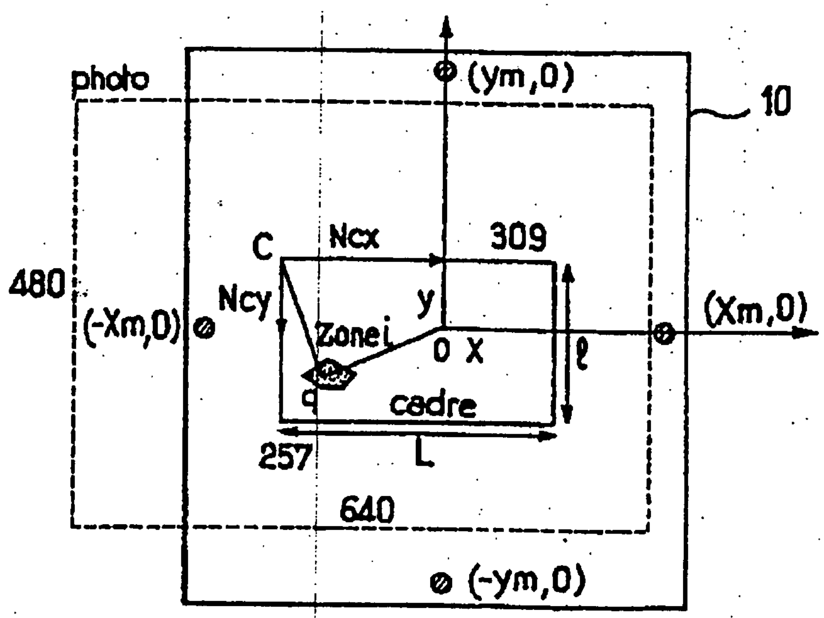


photo
(ym,0)
10
C
Ncx
309
480
Ncy
y
(-Xm,0)
Zone i
0 X
(Xm,0)
ℓ
cadre
257
L
640
(-ym,0)

FIG_12

INTERNATIONAL SEARCH REPORT

International Application No
PCT/FR 99/03252

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 G06K11/14

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 G06K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 96 11378 A (UNIV PARIS CURIE ;NIKOLOVSKI JEAN PIERRE (FR); FOURNIER DANIELE (F) 18 April 1996 (1996-04-18) cited in the application page 16, line 27 -page 18, line 2; figure 15 page 27, line 34 -page 31, line 15	1-5,11, 20-24, 36,37,43
A	EP 0 585 842 A (CANON KK) 9 March 1994 (1994-03-09) column 5, line 26 -column 6, line 35 column 9, line 44 -column 10, line 21	1,2,5, 21,43
A	EP 0 735 503 A (CANON KK) 2 October 1996 (1996-10-02) column 2, line 52 -column 4, line 45	1,2,35

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

° Special categories of cited documents :

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
19 April 2000	27/04/2000

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Bailas, A

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
PCT/FR 99/03252

Patent document cited in search report		Publication date	Patent family member(s)		Publication date
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			US	5862049 A	19-01-1999